
Cellular Adaptation

Morphologic and functional modifications of cells reacting to changes (physiologic) of the external environment

ATROPHY

HYPERTROPHY

HYPERPLASIA

METAPLASIA

From Physiological to pathological

HOMEOSTASIS
(Normal condition)

Very small and continuous morpho-functional modifications in response to requests and triggers, which can be internal or external to the cell

CELLULAR ADAPTION
(Atrophy, Hypertrophy, hyperplasia Metaplasia)

Morpho-functional modifications of cells responding to excessive physiologic stimuli or peculiar pathologic states

CELL DAMAGE

Cell modifications following triggers that overtake adaptive capacities

Reversible

Irreversible

CELL DAMAGE

1st

Molecular

2nd

Biochemical-functional

3rd

Ultrastructural

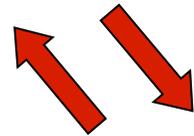
4th

Microscopic

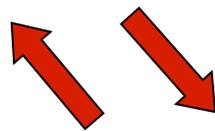
5th

Macroscopic

Normal cell



Adapted cell



Reversible damage



Irreversible damage



Cell death

Cellular Adaptation

External or internal triggers force the cell toward adaptation, thus modifying proliferation and morphology

- ***Cell size***
- ***Cell differentiation***
- ***Mitotic rate***

**Modificazioni
dell'ambiente
cellulare**

**Risposta
della cellula
al danno**

Efficace

**Ritorno
alla normalità**

**Adattamento
cellulare**

Inefficace

Morte cellulare

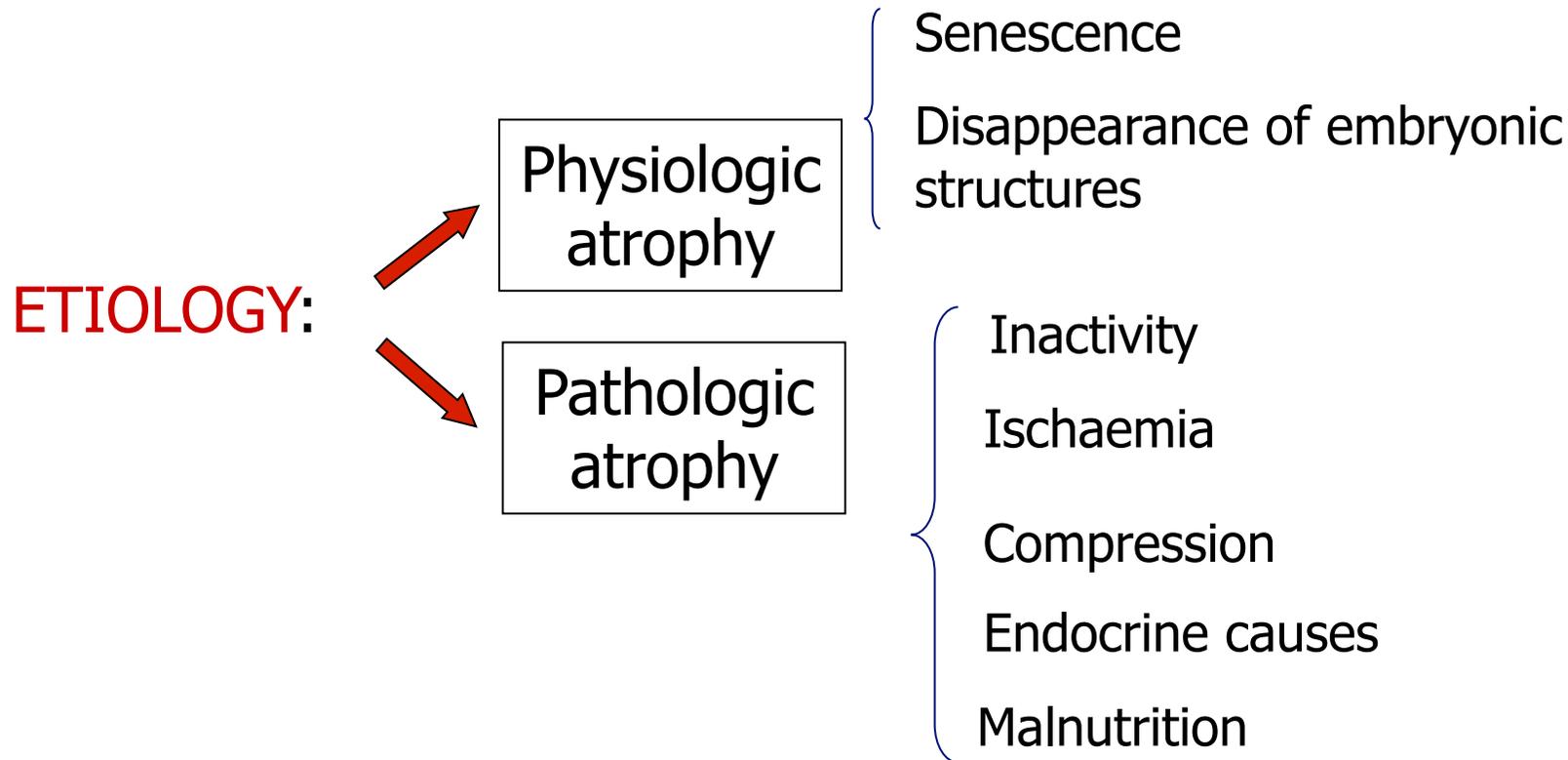
Neoplasia

Cellular Adaptation

Modalities of cellular adaptation

- **atrophy** = decreased cell size
- **hypertrophy** = increased cell size
- **hyperplasia** = increased number of cells
- **metaplasia** = change in cell phenotype/function

ATROPHY = Decreased volume of an organ or a cell



PATHOGENESIS: *reduced consumption of aminoacid and O₂, reduced protein synthesis, increased protein cabolism*

Atrophy: microscopic features

- Decreased cell size
 - Tightening of nuclei
 - Cytoplasmic pigments “wear-and-tear”
 - Substitution with adipose or fibrous tissue (hyalinosis)
 - Organ shape is preserved, size is decreased and consistency is increased
 - Lack of substitution with fibrous or adipose tissue = reduced size
-

Cellular Adaptation

Examples of atrophy

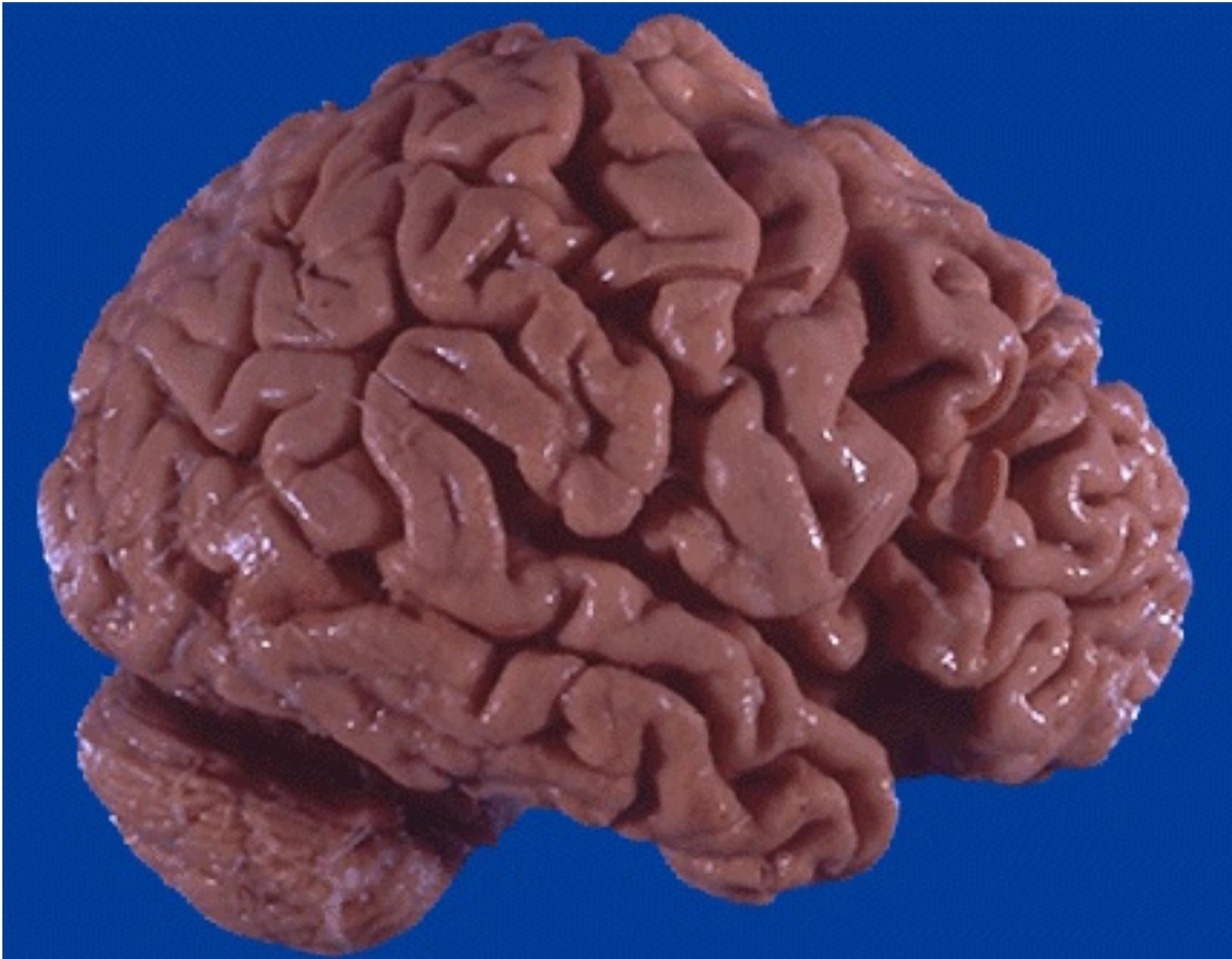
- Lymphatic tissue, bone marrow in elderly people
- Adrenal glands after prolonged steroid therapy
- Inactive skeletal muscle
- Absence of endocrine stimulation on target organs

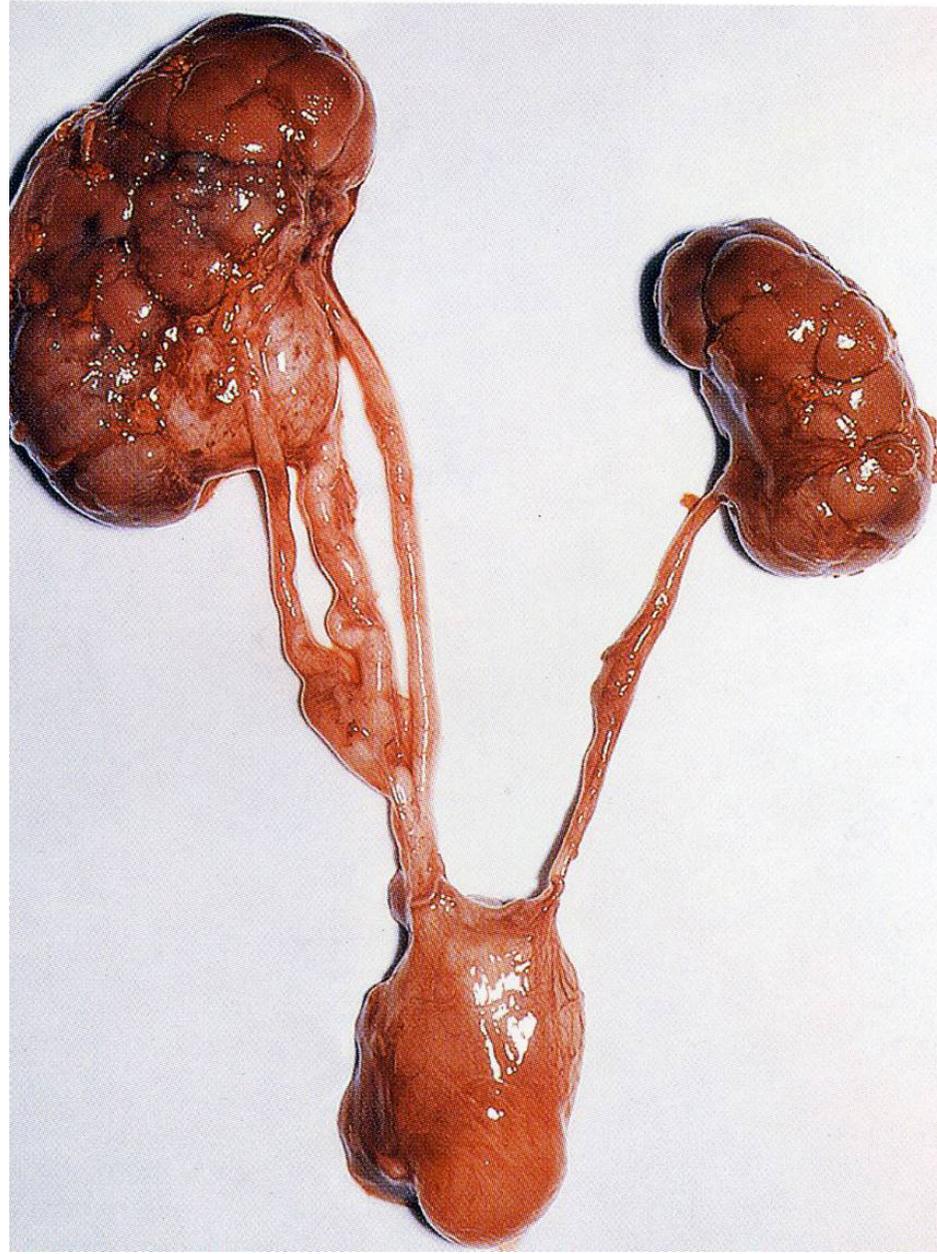
Dd (differential diagnosis):

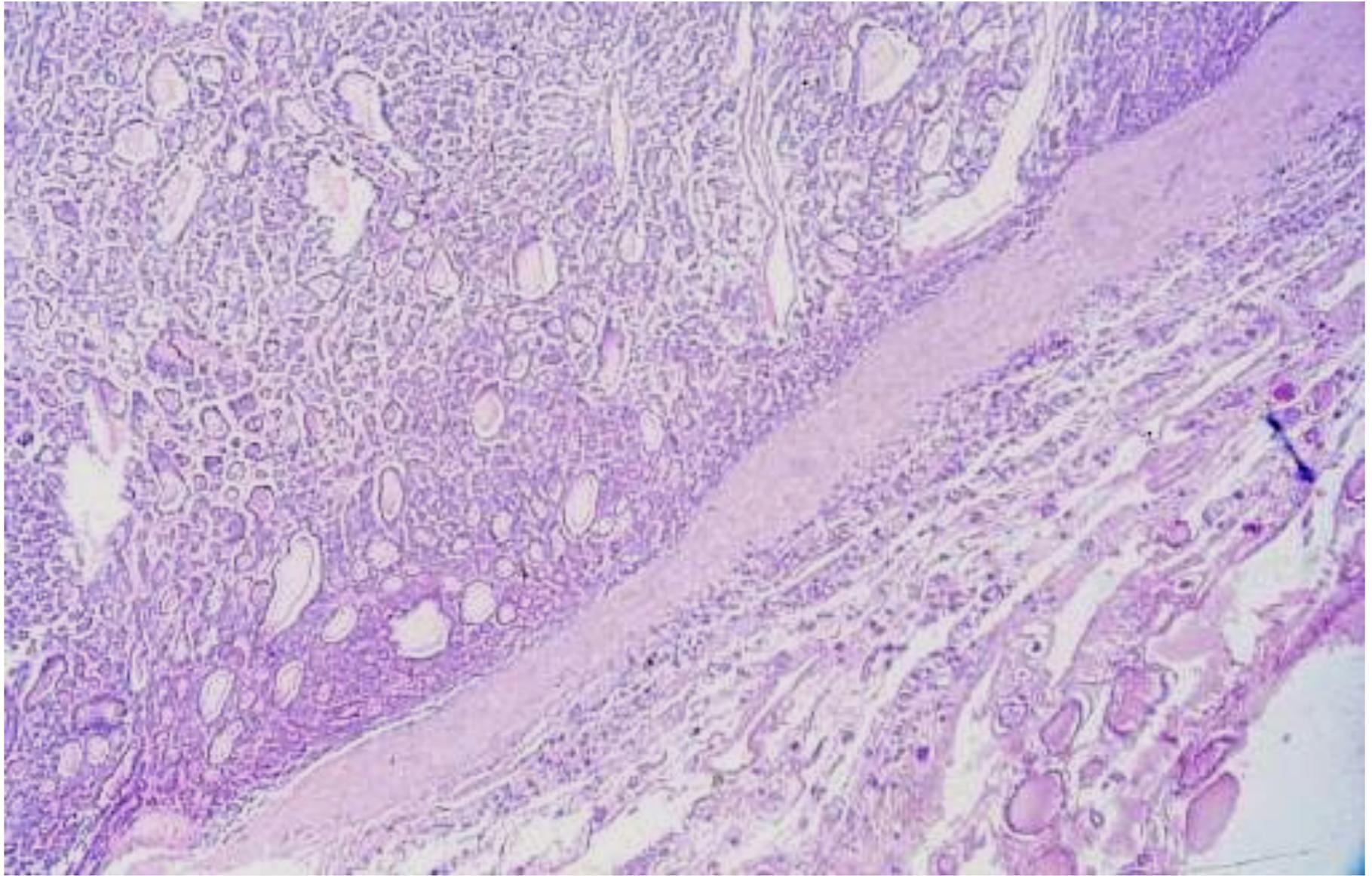
Hypoplasia – incomplete growth

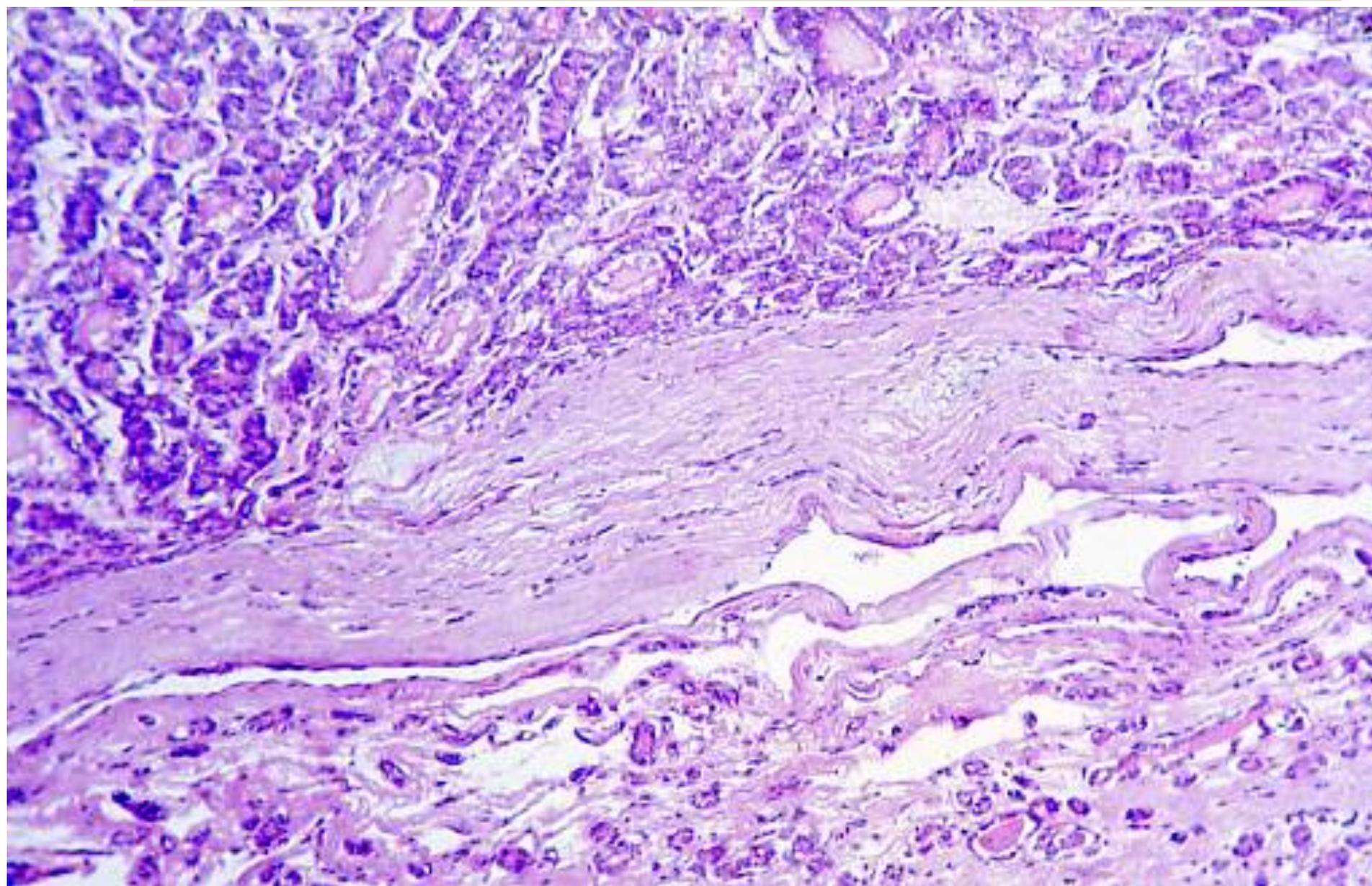
Agenesis – lack of development of an organ



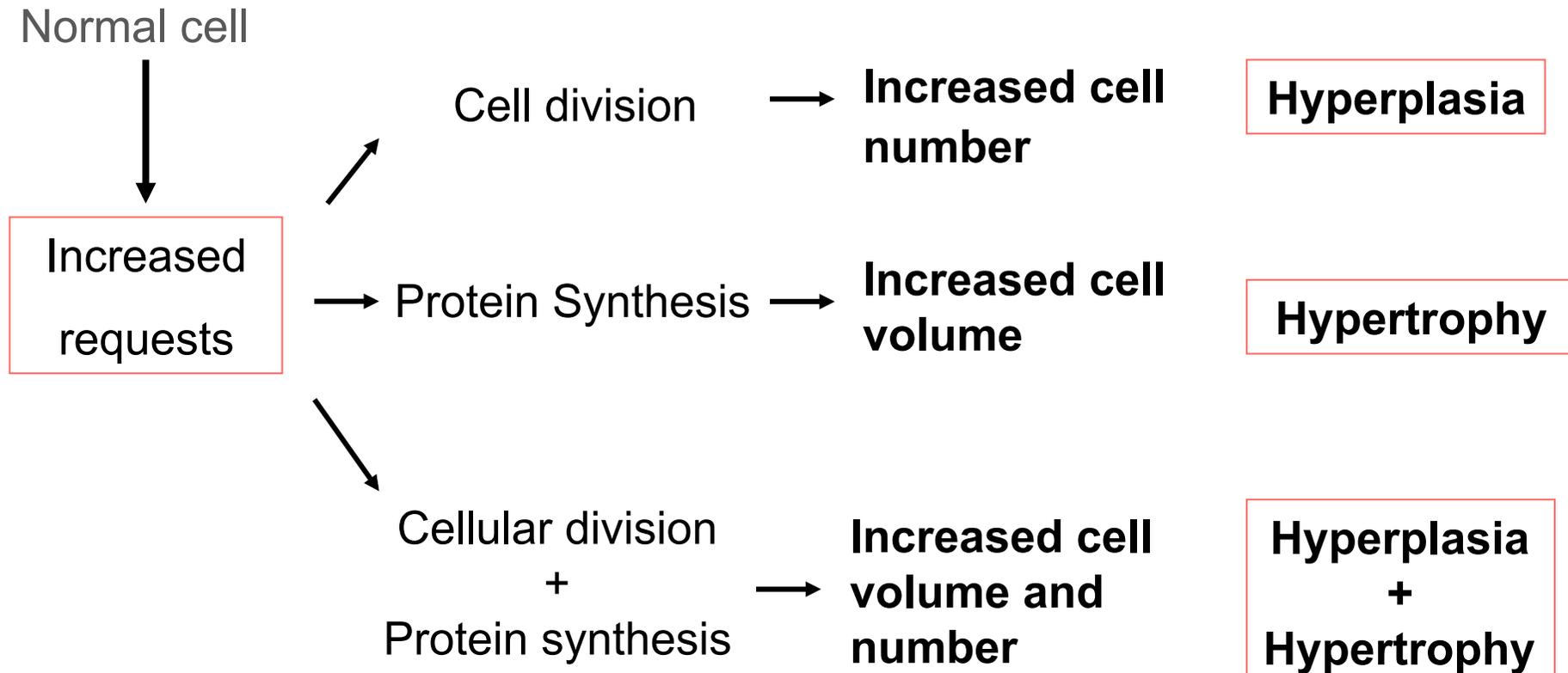








HYPERPLASIA / HYPERTROPHY



Cellular Adaptation

Hypertrophy and hyperplasia

- Respond to well-defined stimuli
- Limited in space and time
- Specific purpose
- Preservation of normal architectural, cytological and functional features of original tissues
- Don't progress
- Regress when trigger disappears

Cellular Adaptation

Hypertrophy

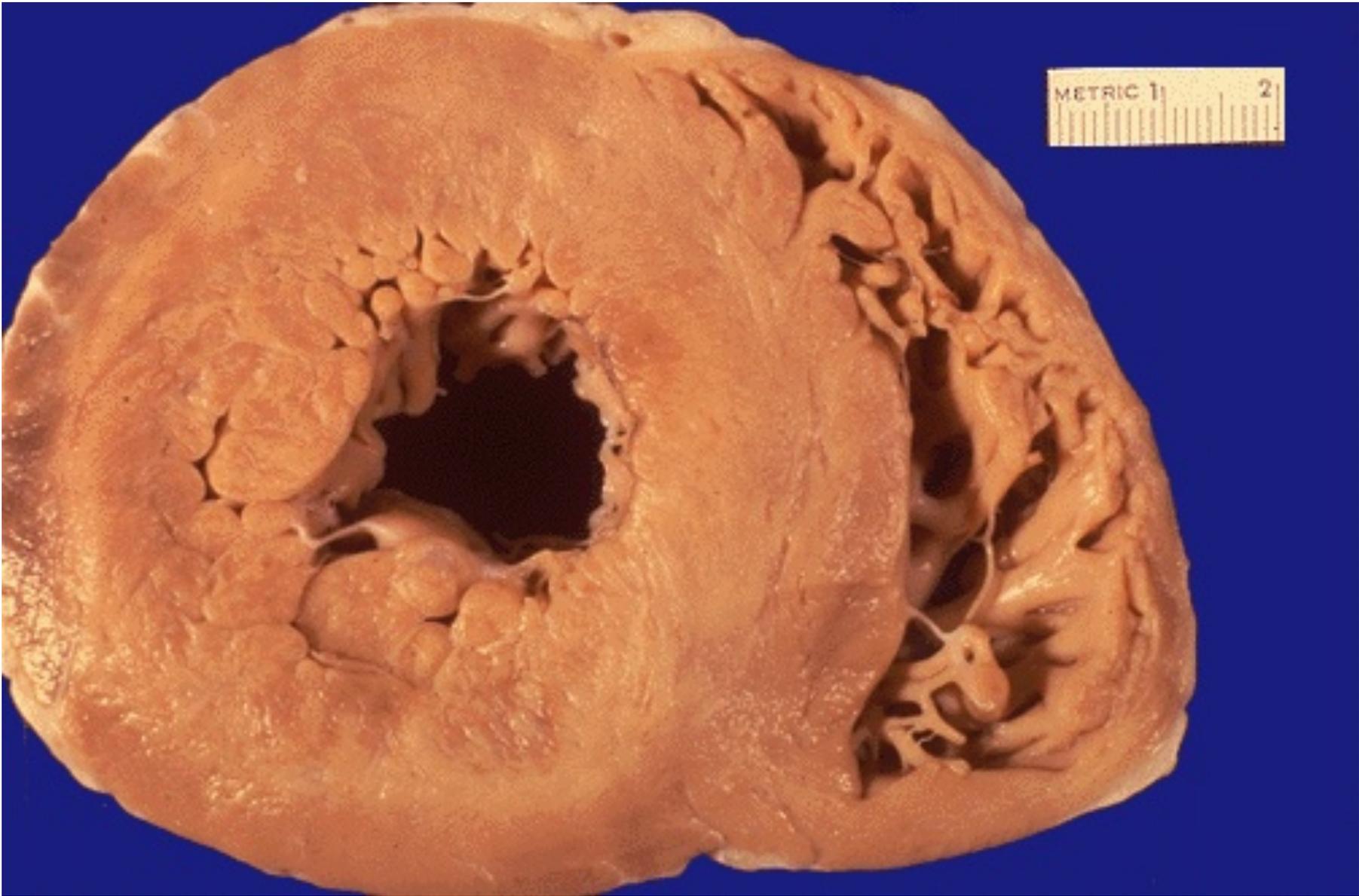
Increased cell/organ size

- Physiologic or pathologic
- CAUSES:
 - increased functional requests
 - specific hormonal stimulation (correlative-endocrine)

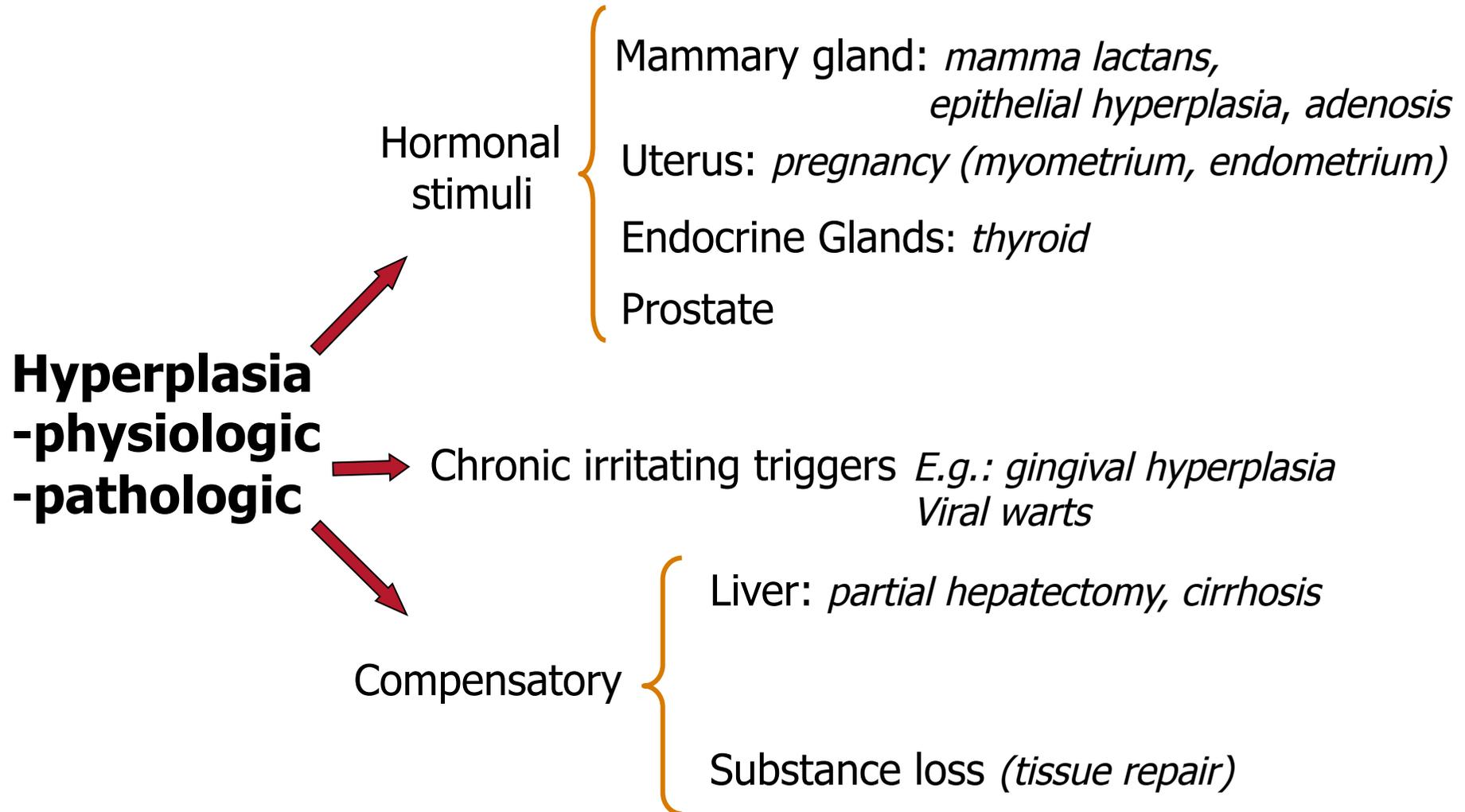
Hypertrophy

PHYSIOLOGIC: - Pregnant uterus
- Skeletal muscle (Increased muscle activity)

PATHOLOGIC: - Myocardial Hypertrophy (hypertension)
- Smooth muscle of hollow organs
(stomach, bladder, ureters) (following
obstruction)



HYPERPLASIA: Volumetric increase of an organ or part of it, due to increased cell number → labile and stable tissue



Pathogenesis of HYPERPLASIA:

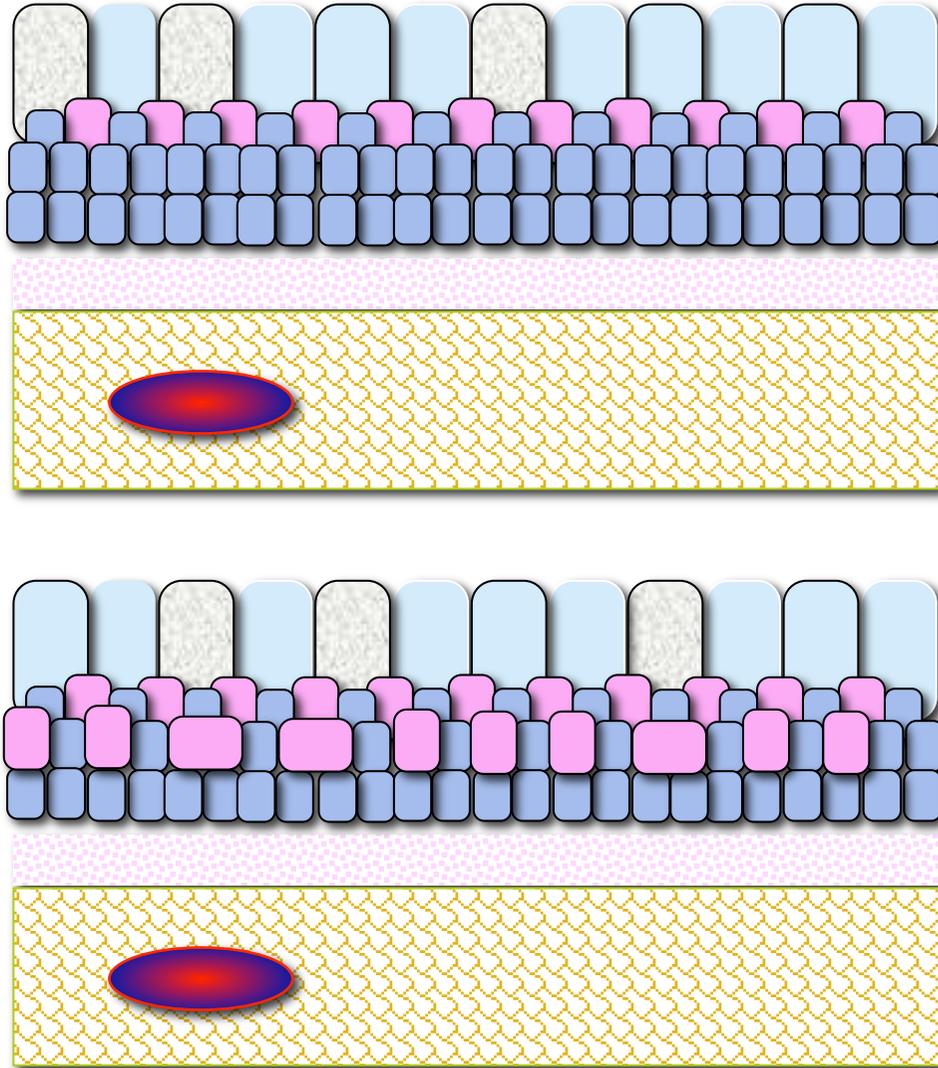
- Production of substances which stimulate or potentiate cell growth (*hormones, growth factors, ecc.*)
- Loss of calons (mitosis-inhibitory substances)
- Prolonged cell survival

Histological features of Hyperplasia:

- Increased cell number
- Cell crowding,
- Multistratification
- Increased mitotic rate
- Light (reactive) atypia

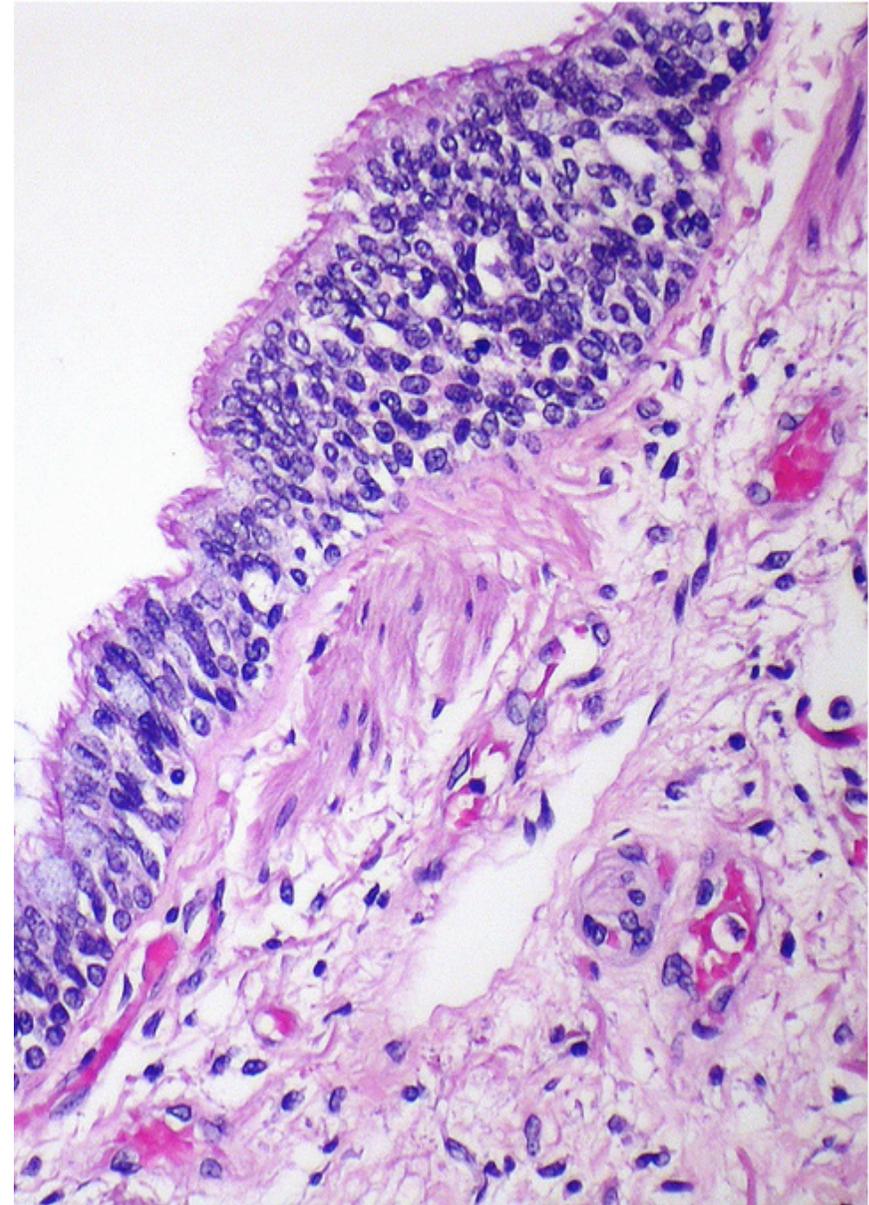
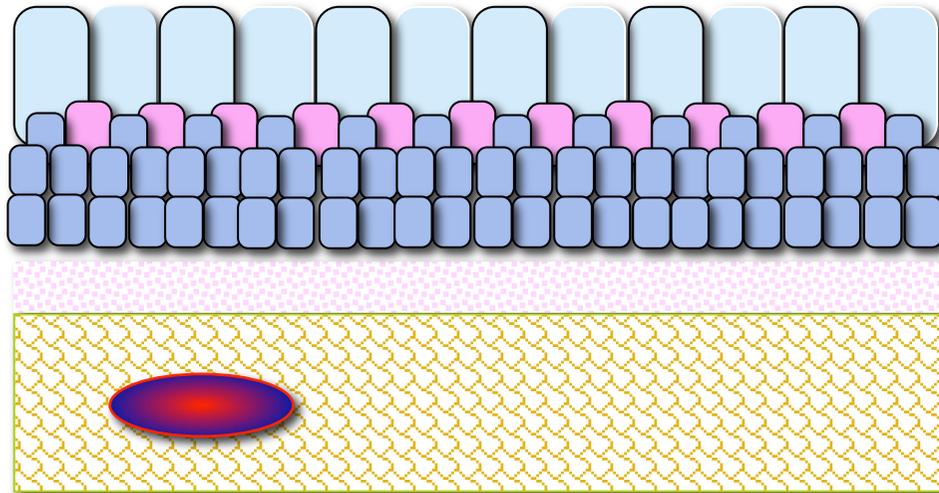
ATYPIC HYPERPLASIA  **“BORDERLINE” LESION**

HYPERPLASIA

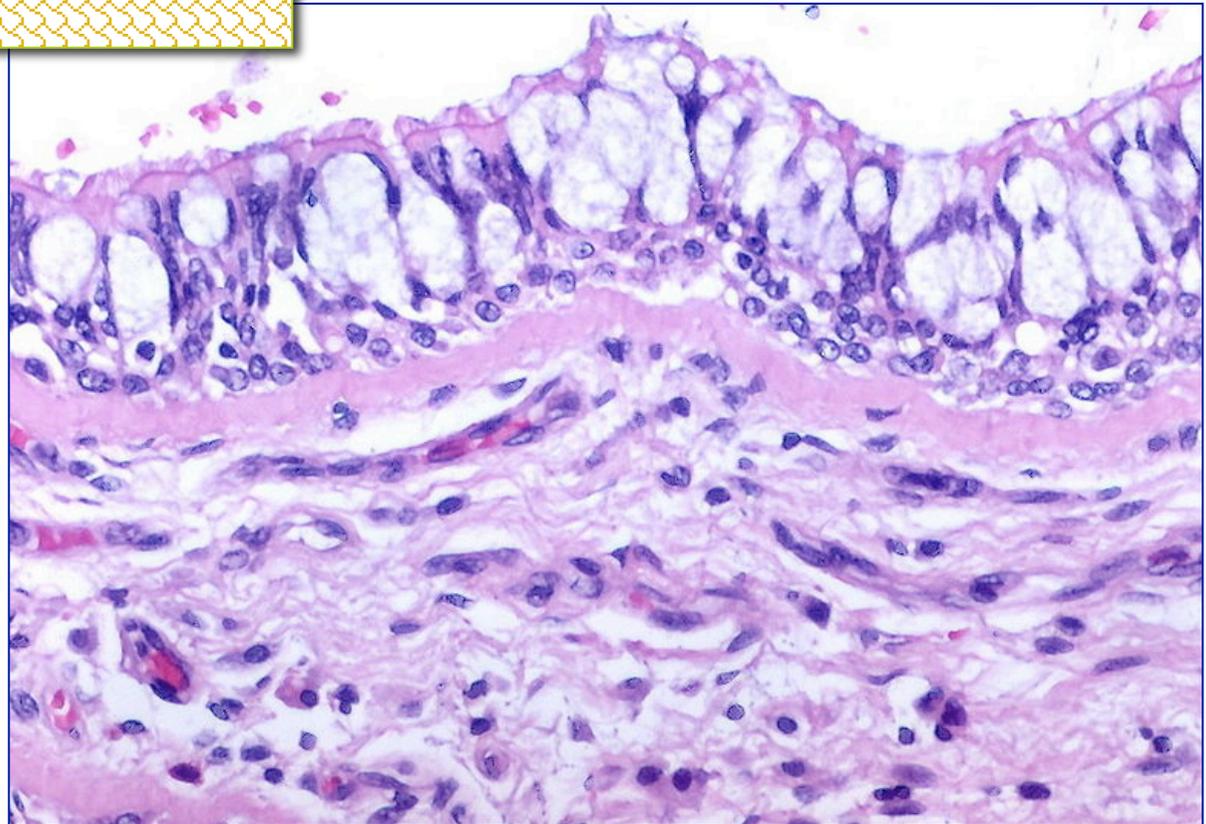
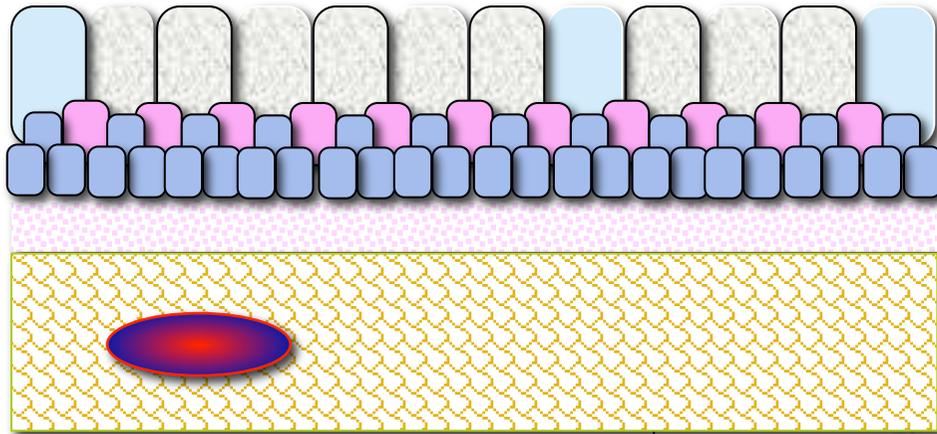


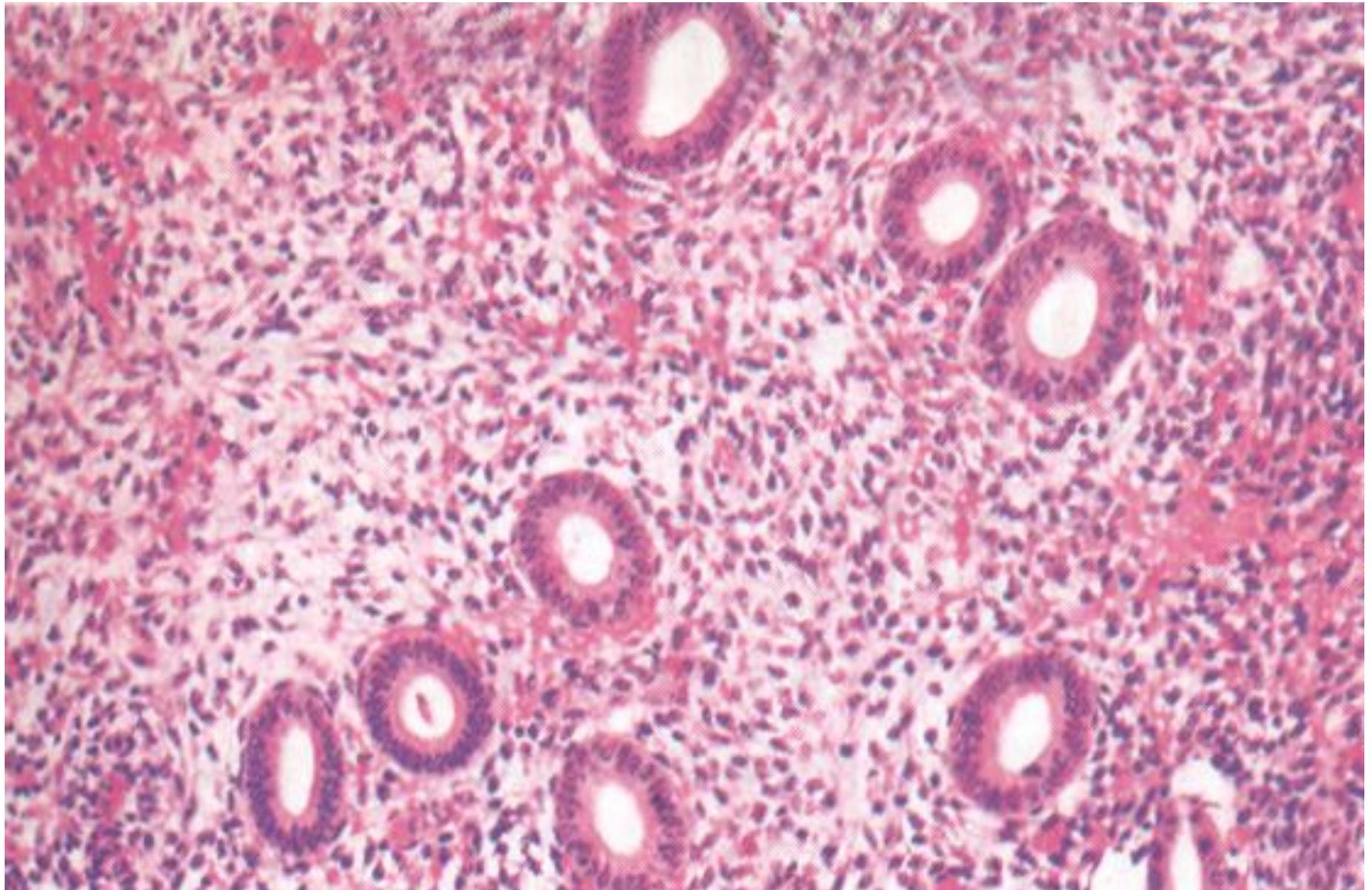
Reactive alteration of cell
Proliferation =
Increased number of normal
components

BASAL CELL HYPERPLASIA



GOBLET CELL HYPERPLASIA





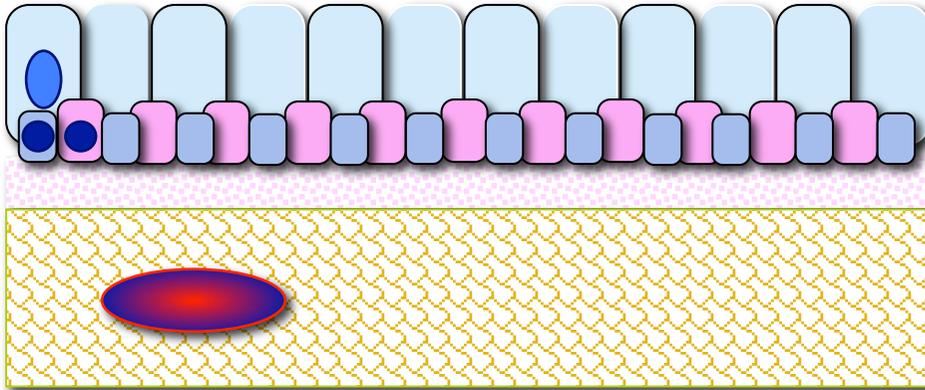


Cellular Adaptation

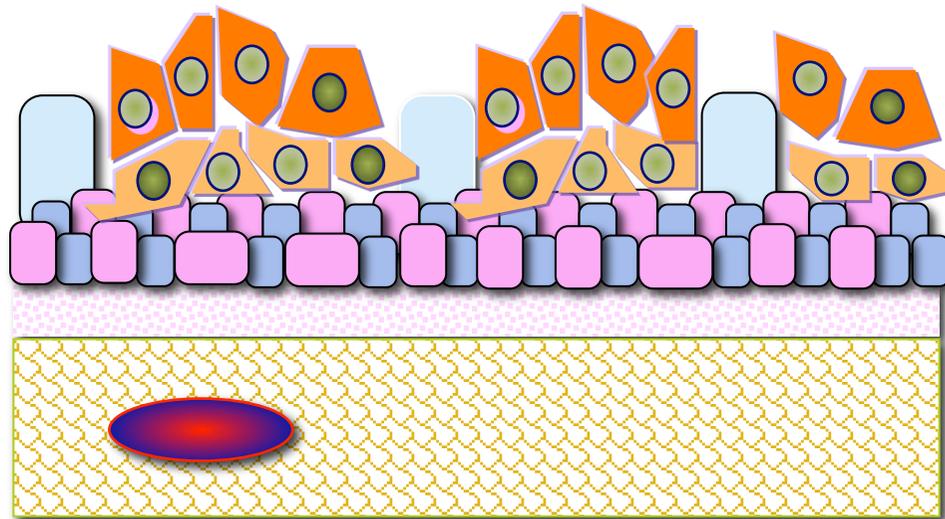
Metaplasia

- Pathologic process of **functional** differentiation
- Cells adapt to environmental and functional changes, modifying their morphologic appearance
- Transformation of tissue in another type of the **same embryologic derivation**
- The transformation of a tissue of ectodermic origin into one of mesodermic origin or viceversa **IS IMPOSSIBLE**

METAPLASIA



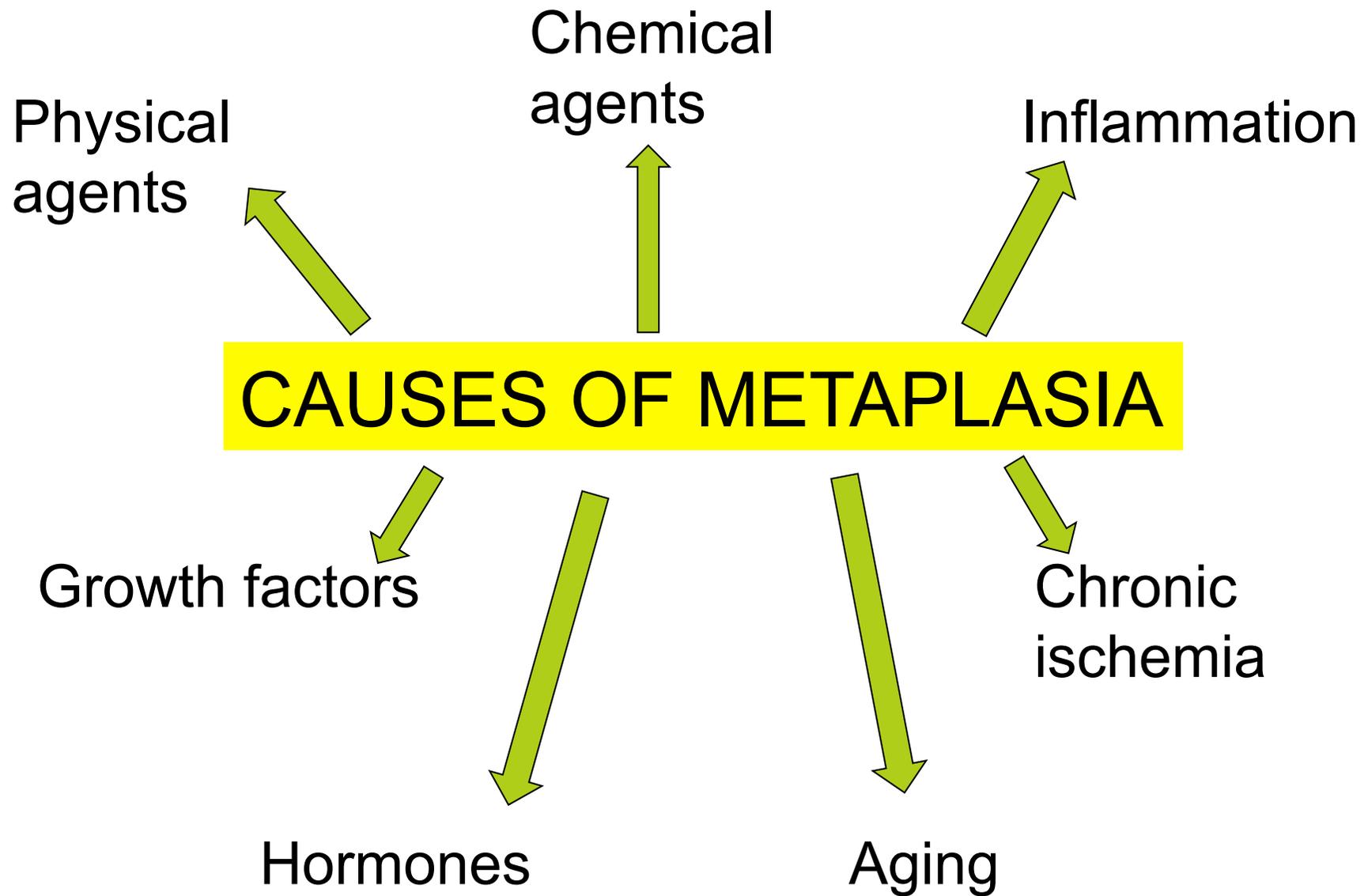
Adaptive change of cell
differentiation =
changes of
functional specialization



Columnar/mucous cell



Squamous cell



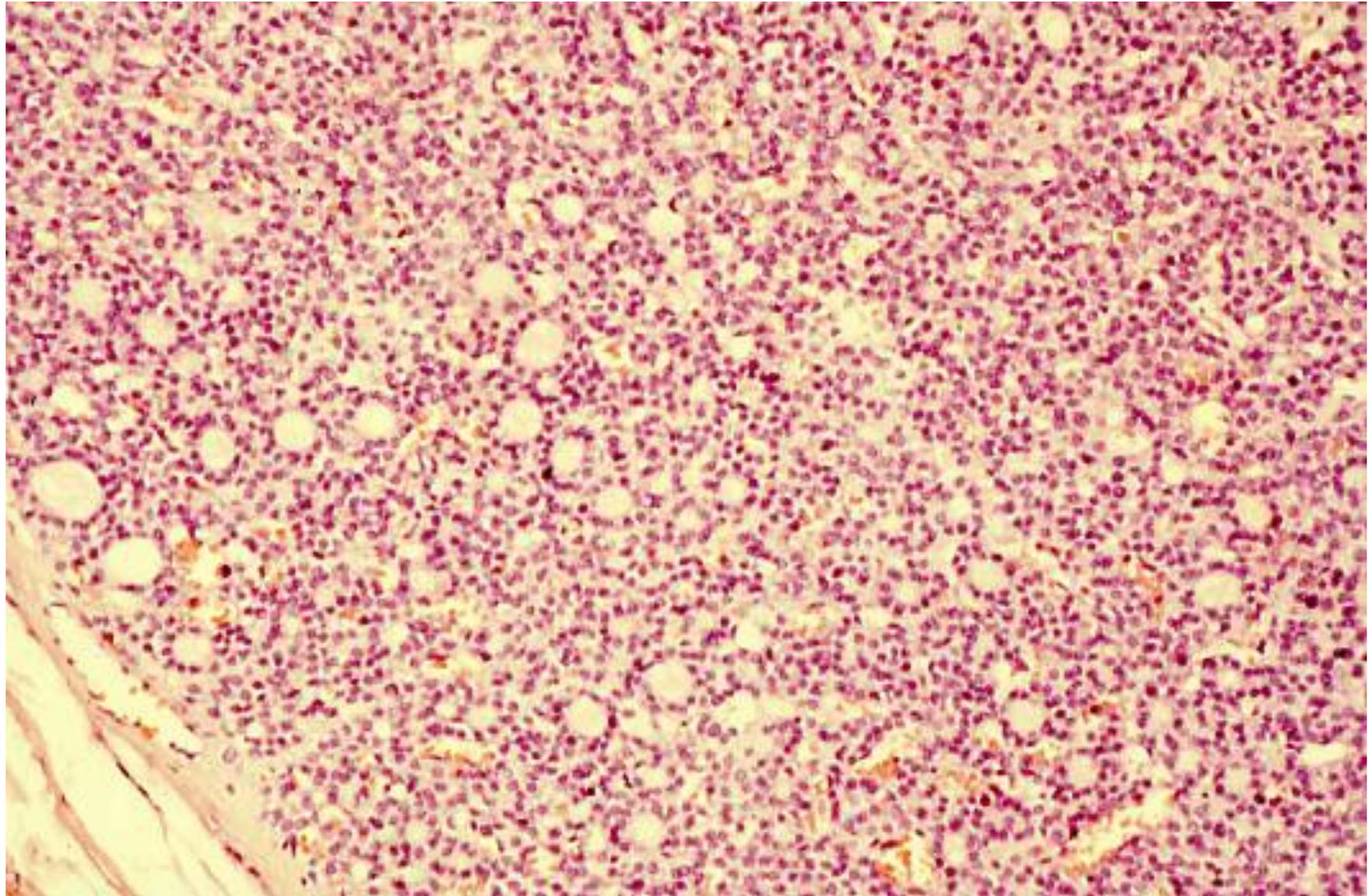
Epithelial Metaplasia

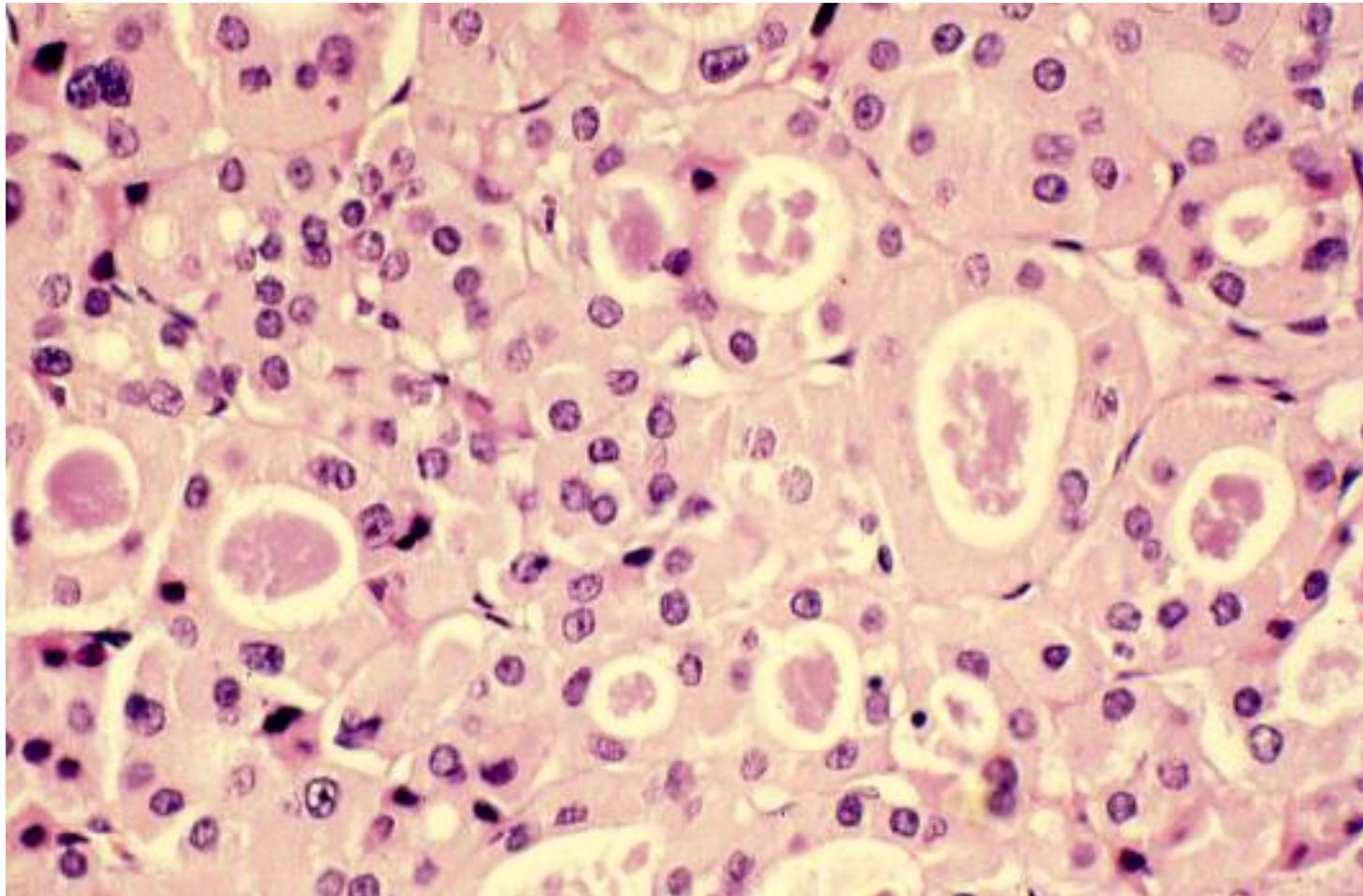
Respiratory epithelium → Squamous epithelium

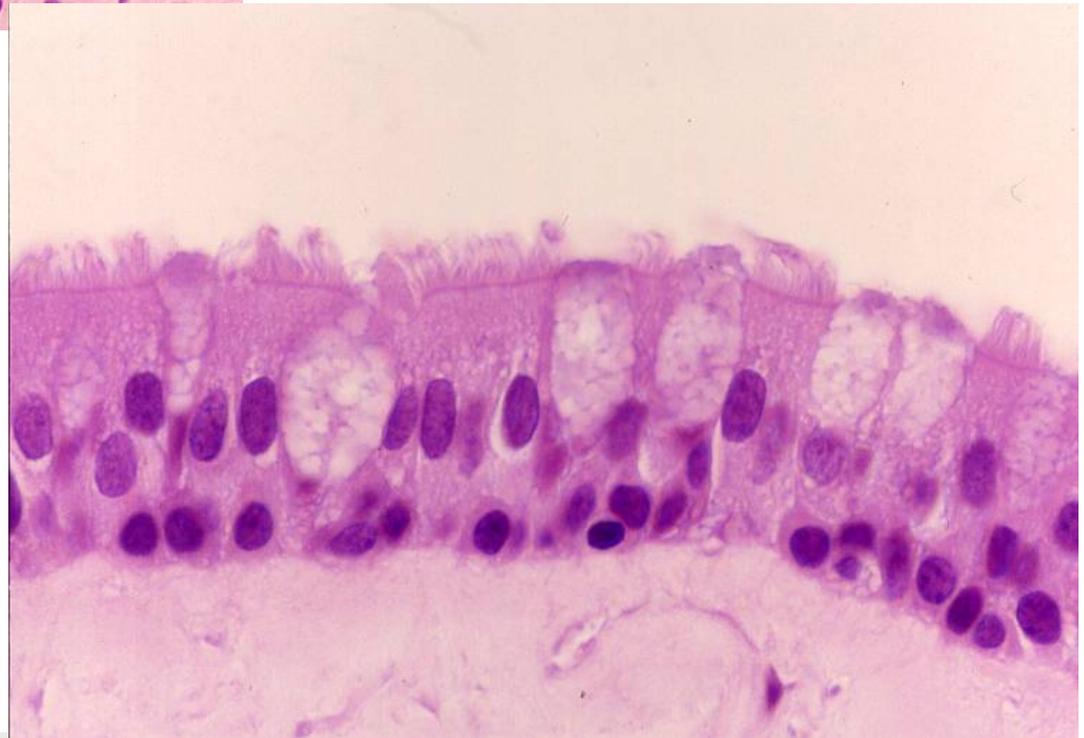
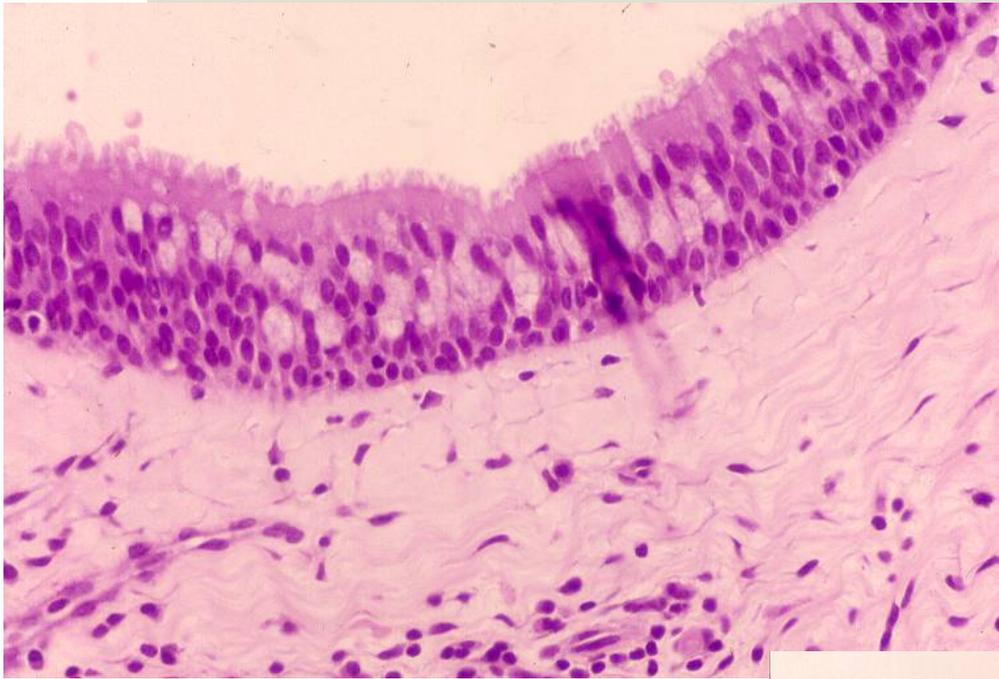
Mammary gland → Apocrine cell metaplasia

Thyroid → Oncocytic metaplasia

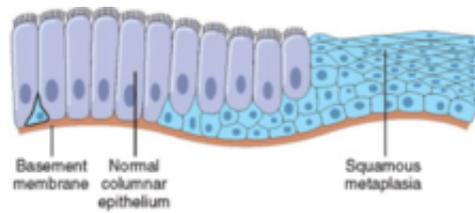
Salivary Glands → Oncocytic metaplasia



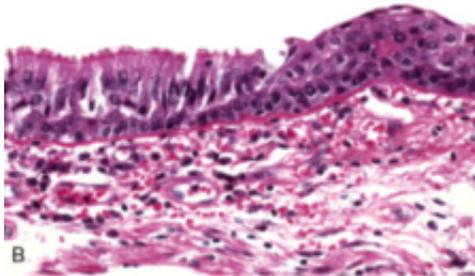




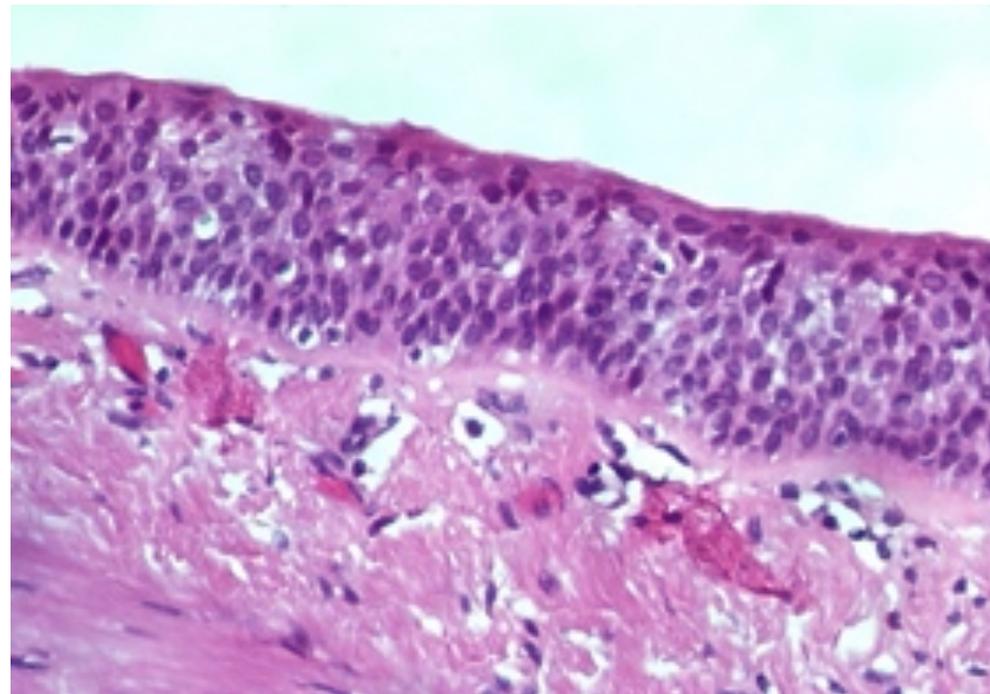
SQUAMOUS METAPLASIA

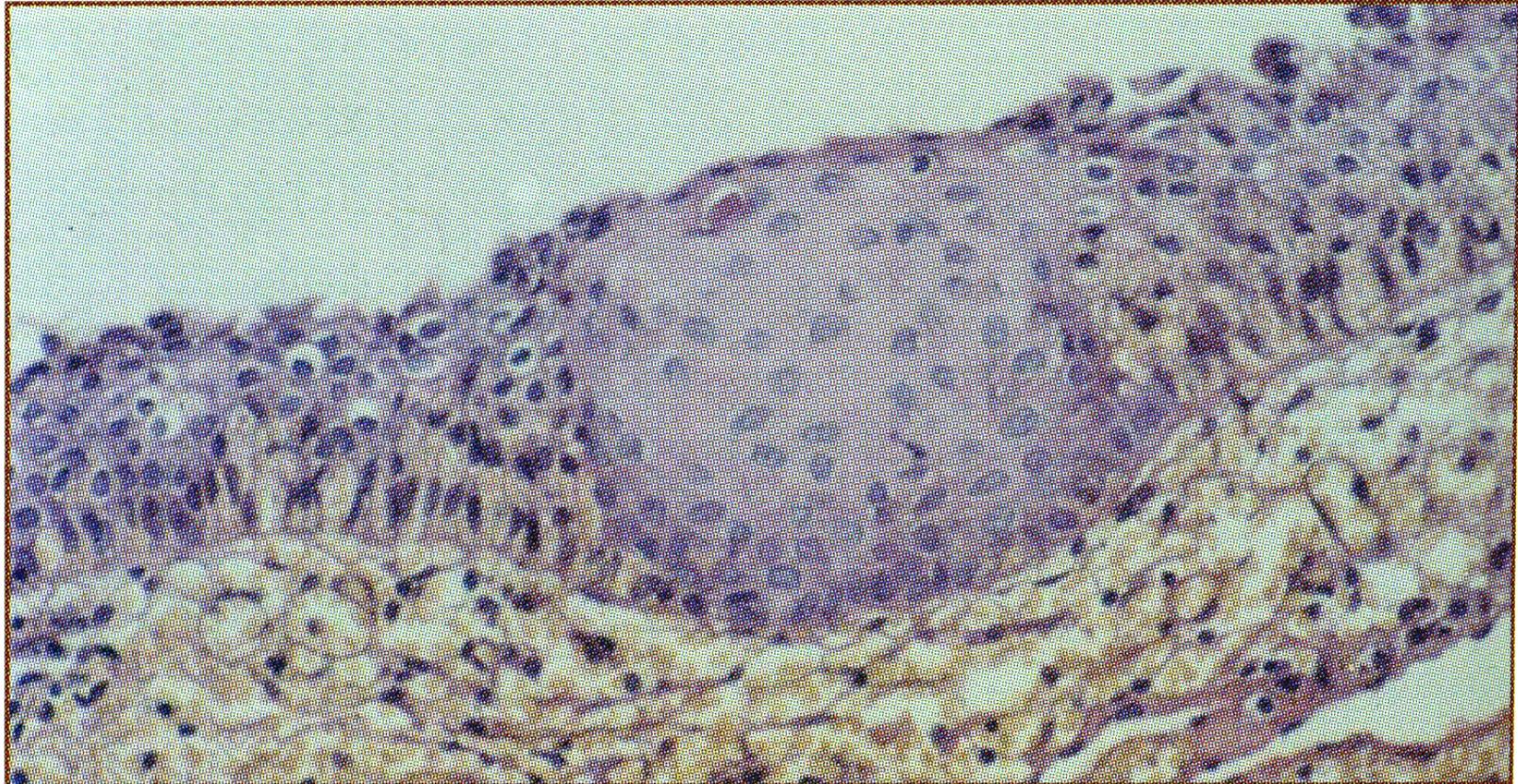


A

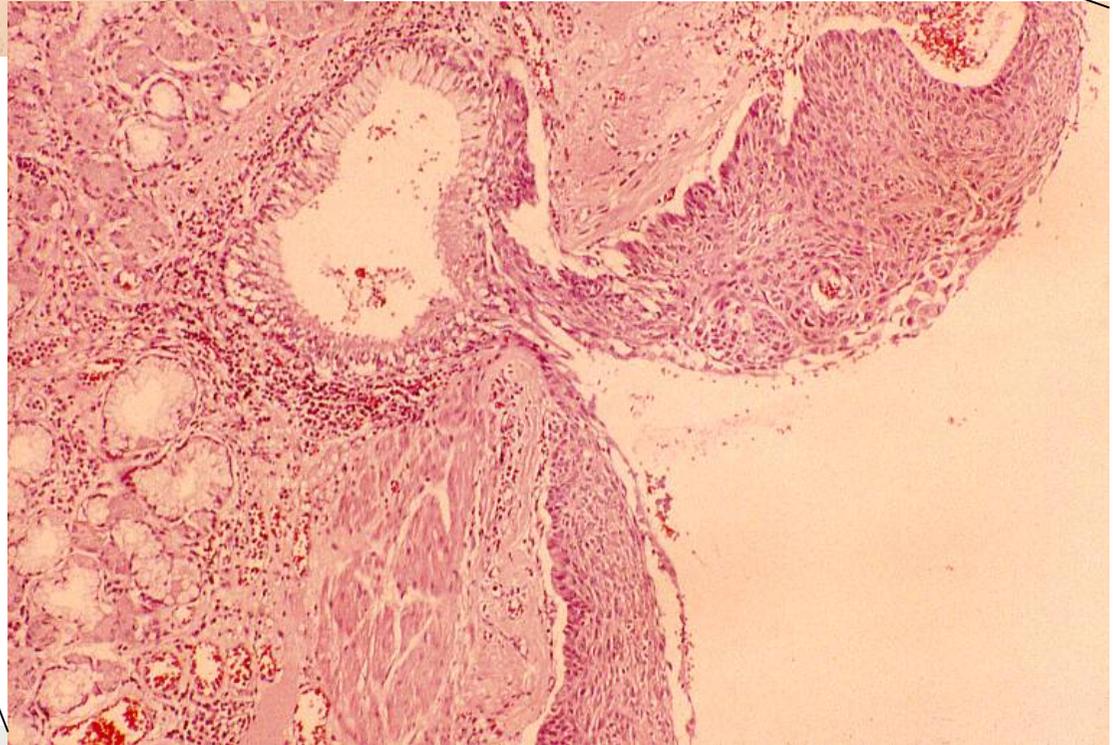


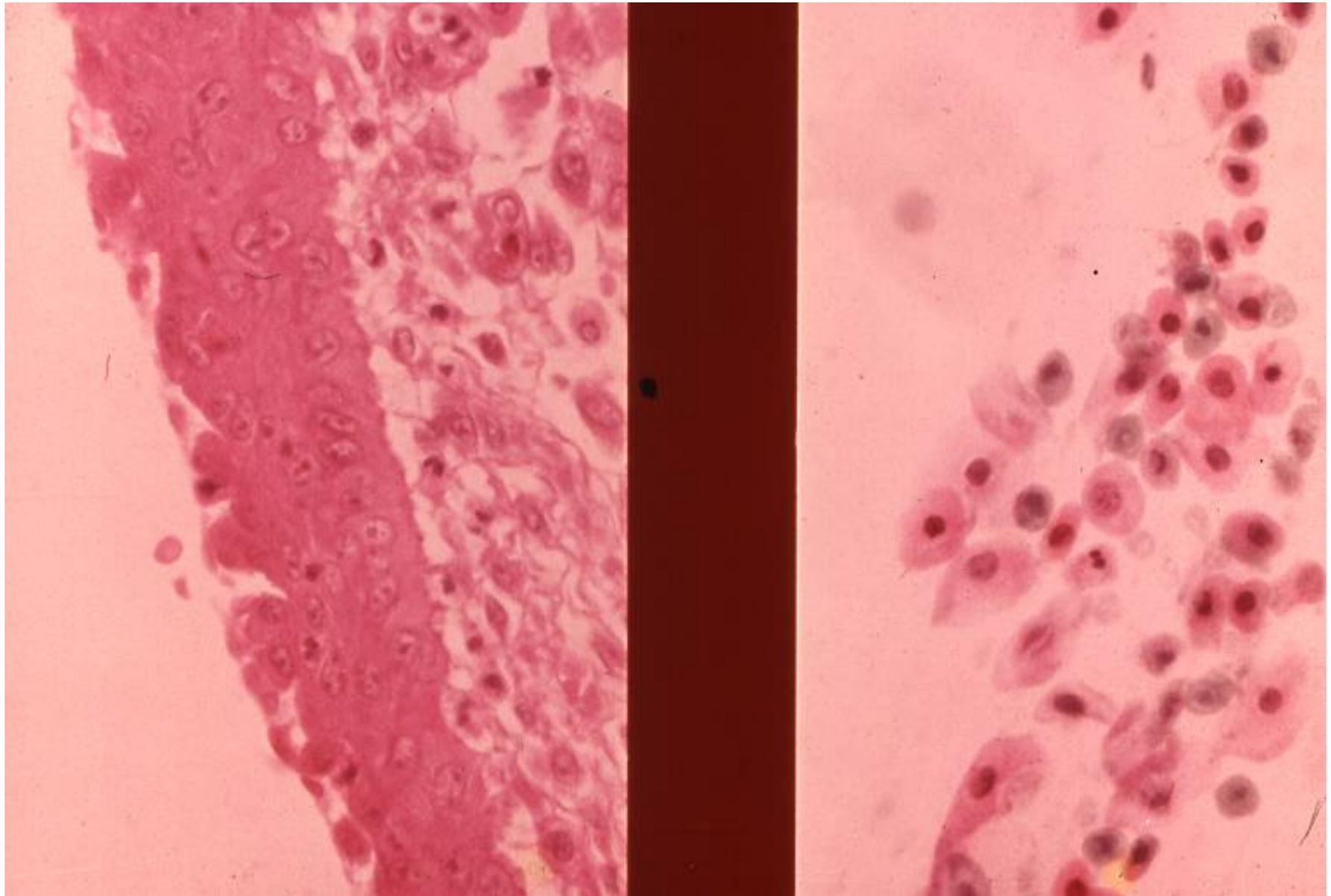
B





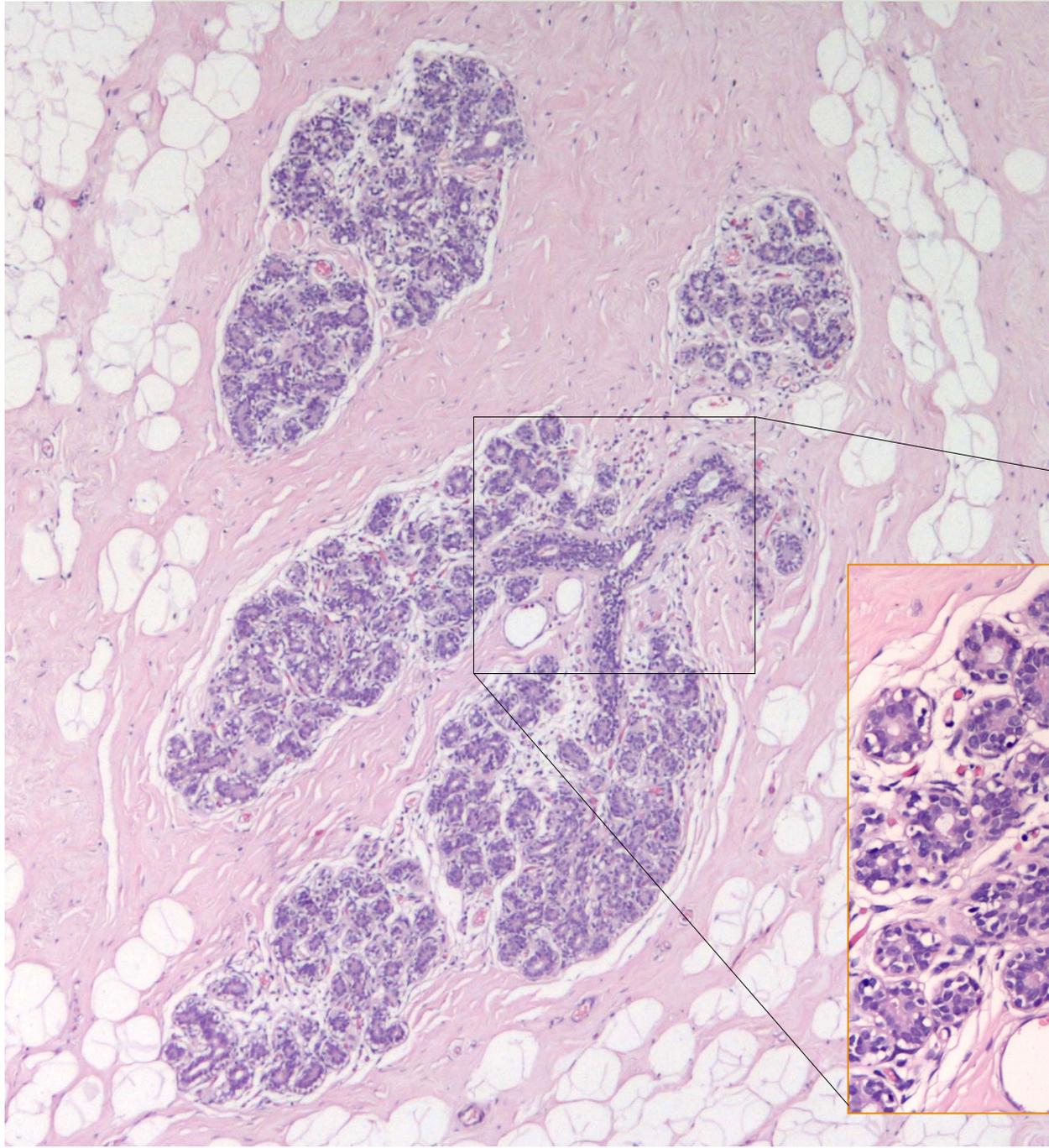
Squamous metaplasia of bronchial epithelium



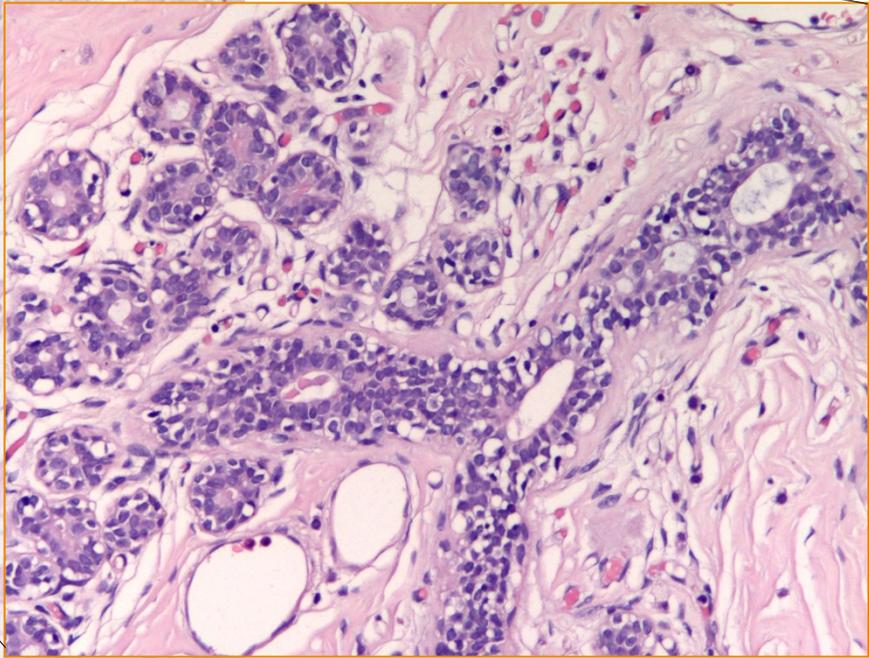


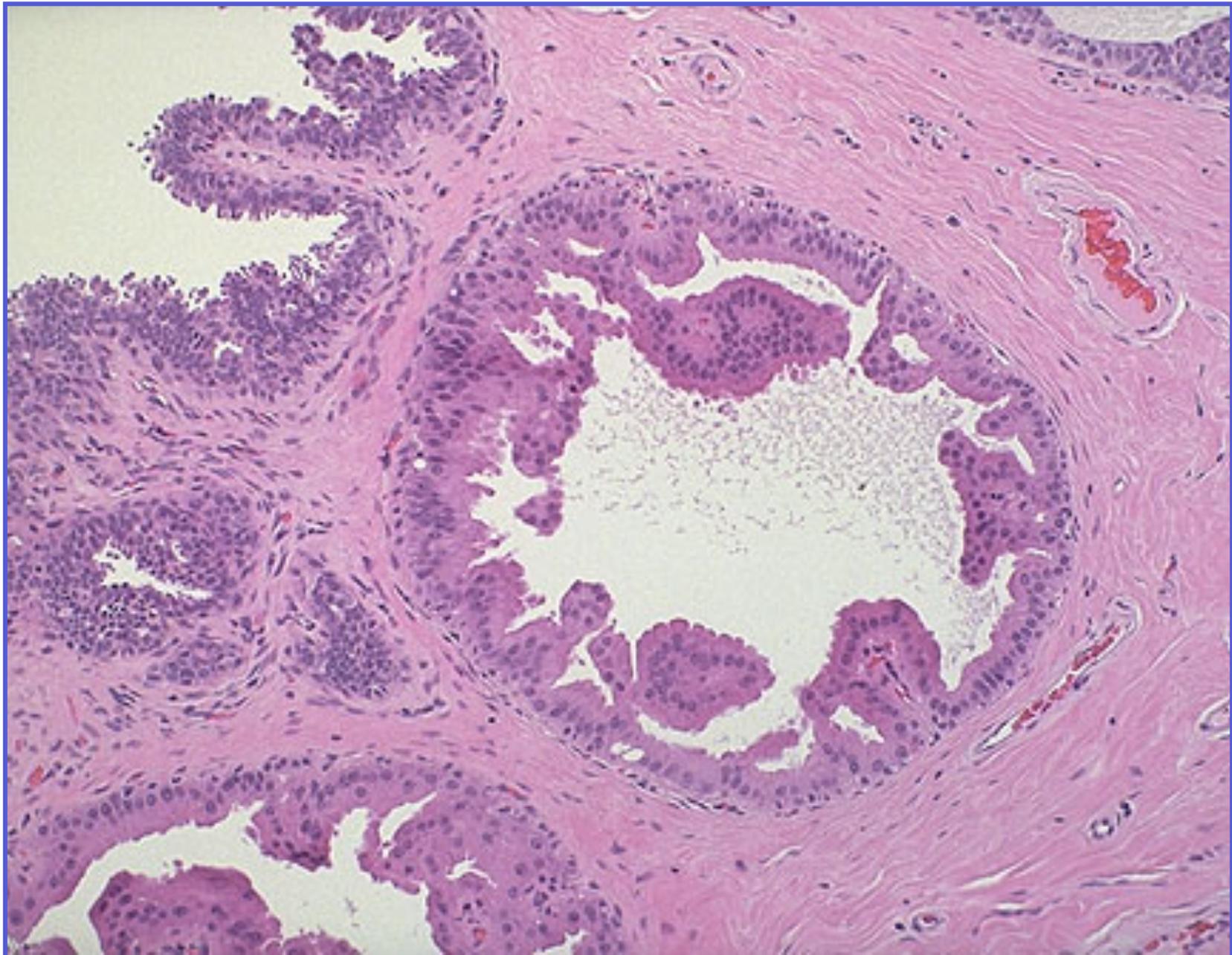


Intestinal metaplasia of stomach

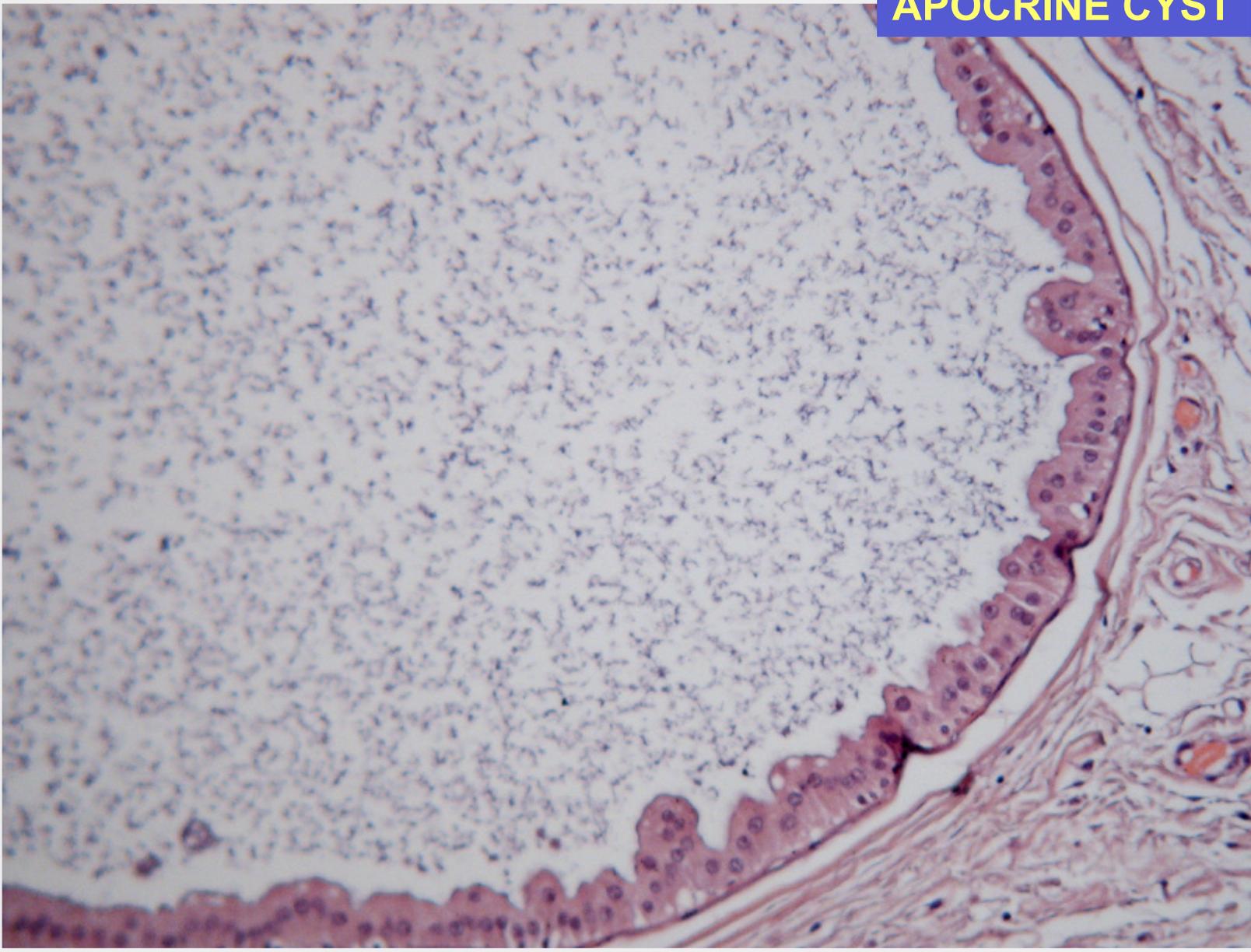


Mammary gland:
TDLU





APOCRINE CYST



Cellular Adaptation

Dysplasia

*Pathologic process of differentiation (**maturation**)*

Spontaneously regresses with withdrawal of the cause

- Organ (e.g., renal) dysplasia = altered maturation during developmental stages
- Cell dysplasia = maturative arrest before endstage differentiation

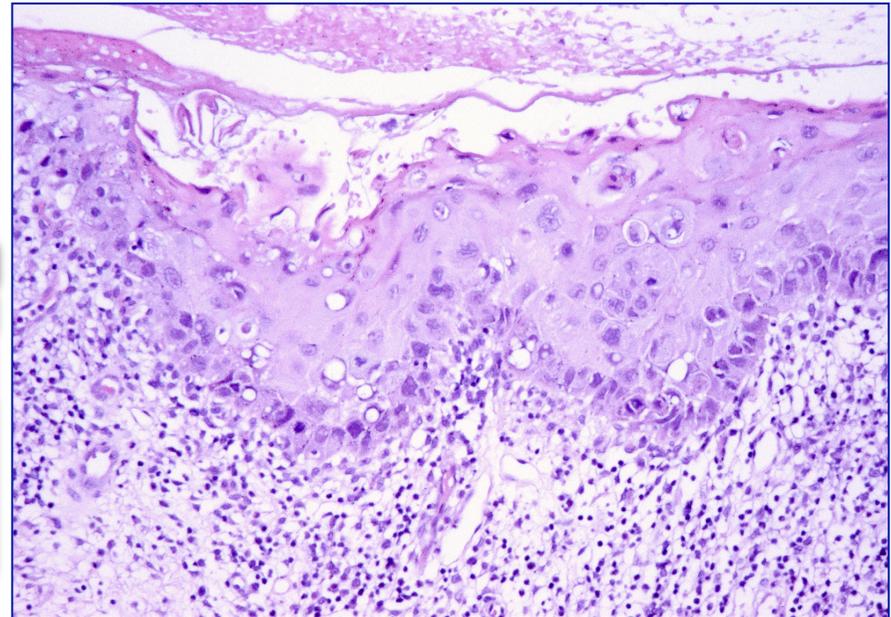
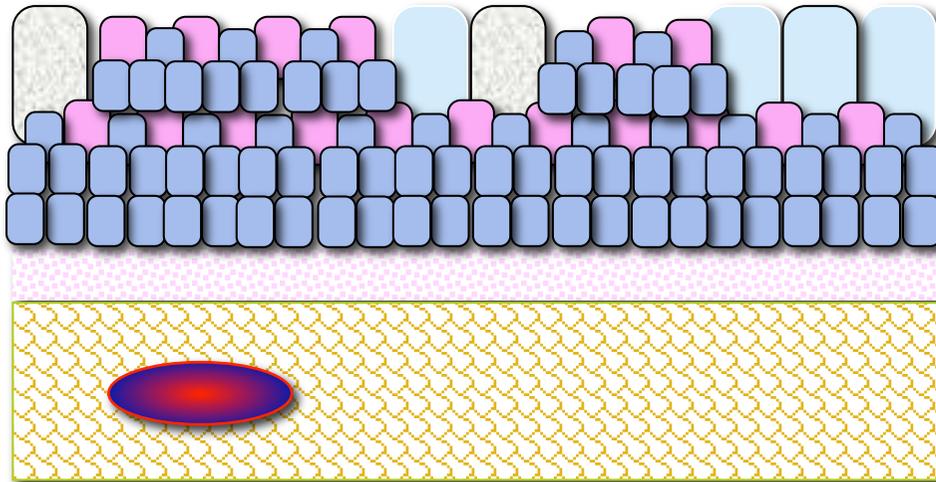
Cellular Adaptation

Cell Dysplasia

- **Maturation arrest**
- **Expansion of the proliferative compartment**
- **Altered architecture, irregular stratification, > thickness**
- **Cytoplasmic and nuclear modifications (increased N/C ratio)**
- **Sites: skin (Bowen's dis.), oesophagus (Barrett's), stomach and colon (adenomatous polyps, IBD), cervix**

DYSPLASIA

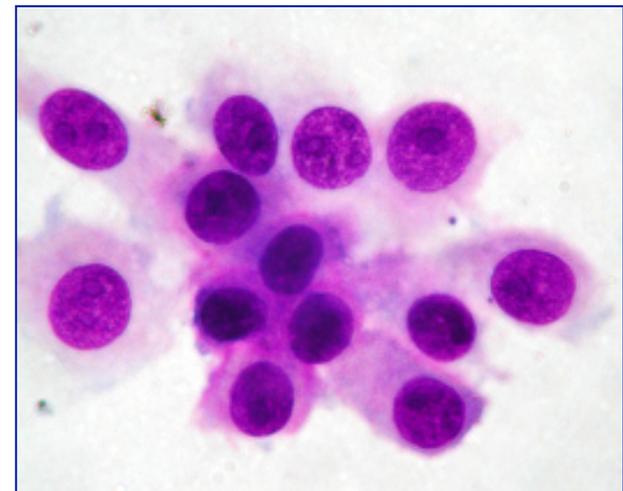
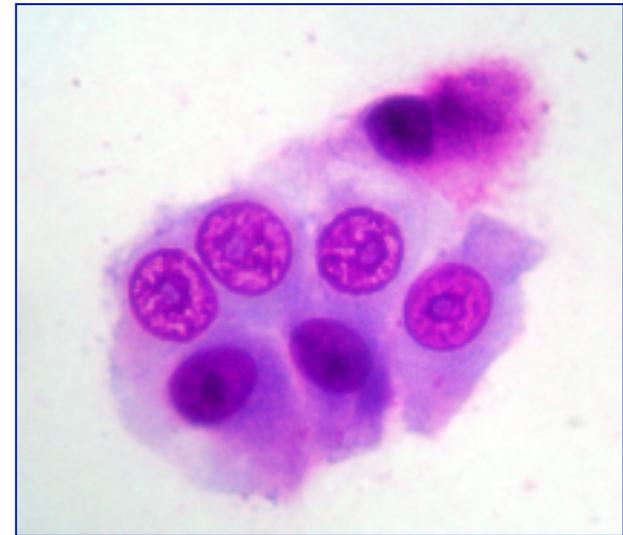
Altered cell **maturati**on =
differentiation arrest with intact
proliferative activity



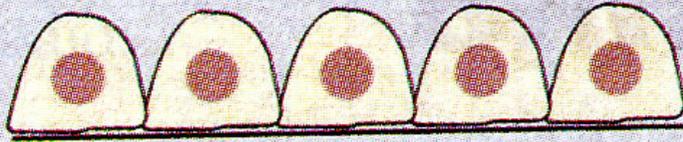
Reactive atypia

Morphological features

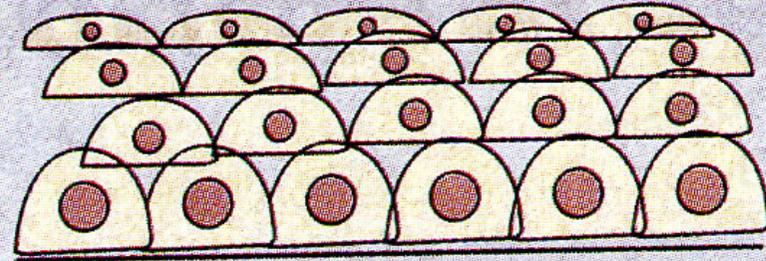
- Intercellular cohesion (clusters)
- Nuclear polarization
- Terminal plaque and cilia
- Nuclear hyperchromasia, nucleoli
- Smooth nuclear contour
- Multinucleation
- Lack of mitotic activity



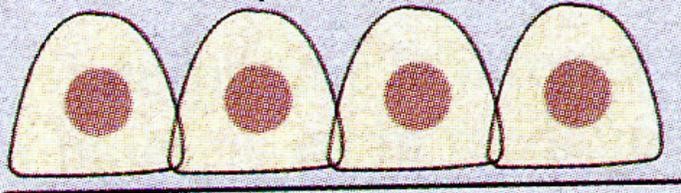
Epitelio normale



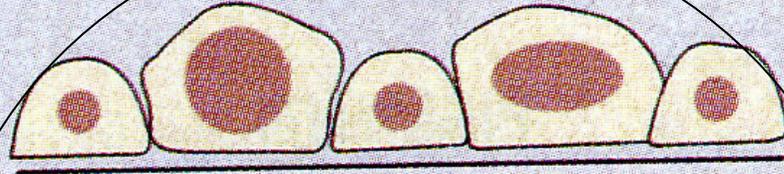
Metaplasia



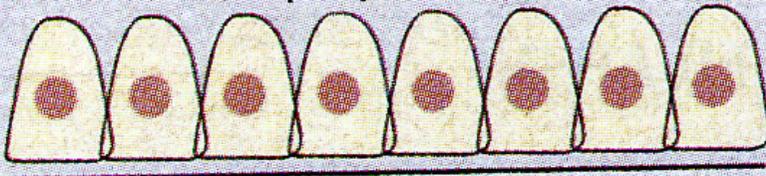
Ipertrofia



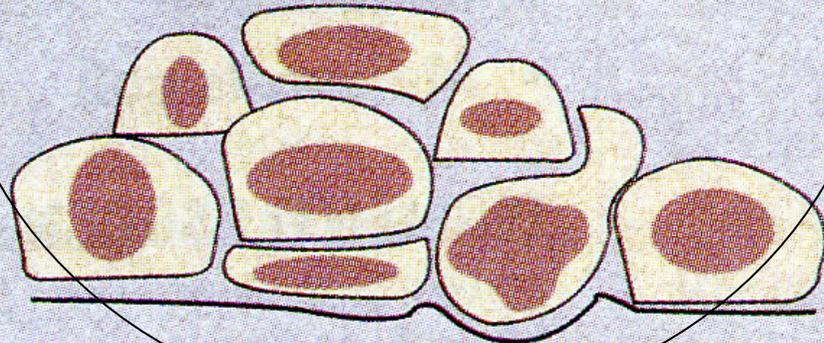
Displasia



Iperplasia



Anaplasia



Atrofia

